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ABSTRACT

This document describes experimental attempts to teach young children the concepts of conservation of number. Subjects were 48 nursery school children who were divided into experimental and control groups. All children were individually pretested for conservation, after which the experimental group alone received two training sessions. The teaching procedures stressed practice with counting objects, one to one correspondence with objects, addition, subtraction, and the concepts "row", and "same". Both groups were posttested. No significant differences between groups due to the treatment procedure were found. Discussion focuses on Piaget's developmental theory, implications for early childhood education, and future research needs. (DP)

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A FAILURE TO TEACH VERY YOUNG CHILDREN TO CONSERVE NUMBER

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Piaget's (1952) theory of cognitive development, especially his theory of the development of conservation, has profoundly influenced research on young children's cognitive development. According to Piaget (1950), specific teaching plays little or no role in the acquisition of the concept of conservation. Piaget concluded that number conservation was not usually present until age 6 or 7 years; therefore, most investigations of number conservation ability have had as subjects children 5 years of age and older. Piaget assumed that there were no differences in conservation ability by sex.

As a test of Piaget's theory of conservation, attempts have been made to teach children to conserve. Results of such studies have largely been equivocal. Studies unsuccessful in teaching children to conserve, interpreted as supporting Piaget's theory that conservation cannot be directly taught, have been reported by Gelman (1969), Wallach, Wall, and Anderson (1967), and Rothenberg and Orost (1969a). Studies successful in teaching children to conserve, interpreted as nonsupportive of Piaget's theory of the development of conservation ability, have been reported by Braine and Shanks (1965) and Mermelstein and Meyer (1969).

The ability of children under 5 years of age to conserve number has received little experimental attention. Rothenberg (1969) found that 6% of her subjects, children 4 years 3 months to 6 years 0 months, were number conservers, and Rothenberg and Courtney (1969) found that 2% of the subjects,

2 years 5 months to 4 years 4 months, were conservers of number. Rothenberg and Orost (1969) successfully taught conservation of number concepts to kindergarten children by instructing them in a logical sequence of component concepts of conservation. No studies, however, concerned with teaching number conservation to children under kindergarten age were found in the literature.

The purpose of this study was to determine whether nursery school children could conserve number and to ascertain whether the ability to conserve number could be taught to nursery school children. The specific hypotheses were as follows: (a) instruction would not be effective in increasing conservation of number task scores of nursery school children, (b) sex would not be a factor in the acquisition of conservation of number, (c) the older children in the nursery school would have significantly higher conservation of number task scores than the younger children in the nursery school, and (d) there would be no significant difference between Posttest I and Posttest II scores.

Method

Subjects

The subjects were 48 children, 25 boys and 23 girls, from the University of North Carolina at Greensboro Nursery School. All children were Caucasian and were from middle-class suburban homes. Subjects were judged to have average to above-average intelligence. The age range was from 43 months to 65 months, the mean age being 54 months. Subjects were matched on age, sex, and Peabody Picture Vocabulary Test

scores and were assigned randomly to experimental and control groups.

Each subject was tested individually by the experimenter, who spent several days becoming acquainted with the subjects prior to testing sessions. Testing and experimental sessions took place during a regular school day in a quiet room apart from other children. The investigation was conducted over a period of 3 weeks toward the end of the school year.

Apparatus

A plywood board, 18" x 24", one-half painted yellow and one-half painted blue, served as a surface on which to place arrays used in the number transformation tasks and in the teaching sessions. The board was described by Rothenberg (1969b). Black checkers were the materials used in the transformation tasks. Materials utilized in the teaching sessions were small 1-inch square wooden blocks, red checkers, plastic cups and saucers from a child's tea set, plastic chairs from a doll house, small wooden-peg painted children, and plastic barnyard animals.

Experimenter and subject sat facing each other in child-size chairs at a child-size table. The plywood board was placed on the table with the blue side toward the subject and the yellow side toward the experimenter.

Pilot Study

A pilot study was carried out with 10 children as subjects, ages 3 through 5 years, to determine the children's reaction to the conservation of number tasks, the teaching sessions and the materials used in them, and to give the

experimenter experience in administering the tests and teaching sessions. The children reacted favorably to tasks and materials. Information gained from the pilot study led to the decisions to limit the length of the teaching sessions to 15 minutes and the number of teaching sessions to two.

Procedure

The procedure was as follows: (a) experimental and control groups were pretested for conservation of number, (b) the experimental group received instruction in conservation of number for two sessions, and (c) both groups received two posttests on conservation of number. Pretests, teaching sessions, and Posttest I took place on successive days. Posttest II was administered one week after Posttest I. Pretests and teaching sessions lasted approximately 15 minutes and posttests required 5 to 7 minutes. The control groups received no special instruction between pre- and posttests. Each subject was given a small piece of candy before rejoining his classmates.

Conservation of Number Test

The conservation of number test was adapted for use with nursery school children from Rothenberg's (1969b) test. The only modification was decreasing the number of items in one transformation task. The test included a warm-up item and the following four transformations: rotation, equal addition, expansion, and collapsing. Five black checkers were placed 3 inches apart on the yellow side of the testing surface and five checkers were placed on the blue surface

parallel to them. Two questions were asked consecutively, regardless of the answer to the first question. The first question was, "Does this row have the same number of checkers as this row?" The experimenter pointed to the appropriate side as the question was asked. The second question was, "Does one row have more checkers than the other row?" The same format was used for all transformations.

Scoring

Scores were weighted. Correct responses were scored 4 points for each item, consistent but incorrect responses were scored 2 points, and inconsistent responses were scored 0 points. The highest possible total score on each test was 16 points. A high score denoted greater comprehension of conservation of number than a low score.

Teaching Sessions

The standardized teaching sessions were modifications of Rothenberg and Orost's (1969b) procedure. Because subjects in this study were younger than the subjects of Rothenberg and Orost, the third teaching session, in which subjects were taught number conservation by children who were conservers of number, was deleted. Standardized instructions were worded so as to be understood by the youngest child. The teaching sessions involved practice in counting objects, in one-to-one correspondence with various objects, in addition-subtraction, and in the concepts of "row," "length," "more," and "same."

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Data Analysis

The experimental design was a pretest-posttest control

group design (Campbell & Stanley, 1963). The independent variable was instruction in number conservation given the experimental group, and the dependent variable was the conservation of number task scores. An analysis of covariance and analyses of variance were computed for the data. The level of significance was .05.

Results

As a test of the hypothesis that direct instruction would not be effective in increasing conservation of number task scores of subjects, an analysis of covariance (Winer, 1962) was computed on Conservation of Number Task Posttest I scores, with the pretest scores as the adjusting variable. Results of the analysis revealed that there were no significant effects due to treatment; thus the results indicated that the null hypothesis could not be rejected. As expected, the results of an analysis of variance (Hays, 1963) on pretest scores revealed that sex was not a factor in the acquisition of conservation of number. The F value was less than 1. As a test of the effects of age on number conservation, an analysis of variance was computed on pretest scores of younger and older subjects. A significant difference was found (F = 10.34, dF = 46; $+< .01$), the older subjects having significantly higher scores than the younger subjects.

An examination of mean scores of experimental and control subjects on Posttest I and Posttest II revealed remarkable similarities. The mean Posttest I score for the control group was 9.42 and for the experimental group was 9.25. The mean score on Posttest II for the control group was 9.25 and for

the experimental was 10.25. Since no treatment effects were found, scores for experimental and control groups were pooled to test for differences between Posttest I and Posttest II. An analysis of variance repeated measures design (Bruning & Kintz, 1968) was computed which revealed that there were no significant differences between Posttest I and Posttest II scores. The mean over-all Posttest I score was 9.50 and the mean Posttest II score was 9.94.

Discussion

Since no significant differences in Conservation of Number Task scores due to treatment were found, it seemed desirable to consider the validity of the instrument of measurement. The Conservation of Number Task was adapted from an instrument developed and validated by Rothenberg (1969). Rothenberg's test was used with 5-year-old children, whereas the subjects in this study were as young as 3 years 7 months. The test was simplified by reducing the number of items in one transformation from 9 to 5.

The test needed to be not so difficult as to be completely beyond the comprehension of the youngest subject and yet not so easy as to be uninteresting and unchallenging to the oldest subject. The range of scores, from 0 to perfect scores of 16, indicated that the difficulty level was appropriate to the age of the children. Presentation of four conservation of number tasks to subjects, the use of two questions after each task, and the scoring method should have precluded "false positives" among the results and contributed to the validity of the results.

Subjects were not required to give explanations of conserving responses because young children, nursery school age, were known to give largely inadequate or no explanations. Requiring explanations possibly would have resulted in "false negatives."

The fact that no effects due to instruction were found and that there were differences in Conservation of Number Task scores by age supported the notion that the development of the ability to conserve number is a function of age and level of development rather than of instruction. When the subjects were divided into two groups according to age, only one child (4%) of the younger half of subjects, 43 to 53 months, made a perfect score on the conservation of number pretest, whereas eight subjects (33%) of the older half of subjects, 55 to 63 months, made perfect scores. It may be that children who acquired conservation after instruction, as in Rothenberg and Courtney's (1969) study with 5-year-olds, were already on the brink of conservation.

Most 5-year-olds, according to Piaget's theory, are in the intuitive stage of cognitive development, i.e., a transition stage between examining phenomena perceptually in the preconceptual stage and judging phenomena logically in the period of concrete operations. Observations of subjects' behavior during testing sessions revealed that fewer of the younger subjects counted objects before responding to the item questions than did older subjects. This information may be interpreted in terms of Piaget's theory that nonconservers, in the preconceptual stage, attempt to solve transformation

problems on the basis of perception. It may be assumed that subjects who counted items before responding to questions about the transformations were in the intuitive stage, even though correct responses were sometimes given. According to Piaget, the child in the concrete period of development who conserves number does not need to reflect in order to be certain of conservation.

In summary, the findings supported Piaget's contention that teaching has little influence on the acquisition of conservation of number. It appeared from the results of this study that the age at which a child is categorized as a conserver of number is dependent upon the criteria of conservation and the difficulty level of the instrument. The results supported Braine and Shanks' (1965) suggestion that when younger subjects are alleged to be conservers, the finding is probably due to difference in methodology and criteria for conservers.

The investigator recognizes that the effects of two teaching sessions cannot give a definitive answer to the effects of teaching on conservation of number acquisition. An investigation of the effects of instruction in number conservation over a period of months is needed; possibly intact preschool classes could be used to compare treatment and no treatment conditions. Further investigations of the number conservation ability of preschool children would profit from video taping sessions in order to study subjects' facial expressions, verbalizations, and counting behavior. The feasibility of using different but comparable pre- and posttests deserves consideration, e.g., the use of different transformations and

different materials in conservation of number pretests and all consequent posttests would possibly alleviate subjects' loss of interest and decreased motivation on posttests.

Implications for Teachers of Very Young Children

Piaget designed conservation experiments in order to study the cognitive processes in young children. Through such experiments he was able to describe the progression of thought processes through the phases of global perceptual judgments, intuitive operations, and logical concrete operations. Teachers of young children can use the Piagetian tests to assess the level of cognitive development of children and as a means of understanding children's cognitive development, but teaching to specific tests appears, from the results of this study, to be futile.

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